SKI AND SNOWBOARD LUBRICATION SYSTEM

Field of the Invention

The present invention relates to skis and snowboards, that is devices adapted to glide across snow or other surfaces, such as artificial ski matting.

Background to the Invention

Skis and snowboards are well known devices for enabling people, vehicles and other apparatus or equipment to glide over snow and other surfaces. Sports skis for attachment to boots are very well known, as are skis for use as landing gear on aircraft, and use on vehicles such as skidoos etc. Skis may also be referred to as runners, for gliding over snow. Snowboards may also be referred to as snowblades. Thus, the term "ski or snowboard" will be understood to encompass runners, snow blades and other such devices for gliding over snow or other surfaces.

The lower surface of a ski or snowboard that is in contact with the snow (or other glide surface) is known as the running surface. In many instances it is desirable to reduce friction between the running surface and the glide surface as much as possible. The glide surface in this sense is any surface over which the ski or snowboard is adapted to glide.

For example, skis for recreational and sports use may comprise bases (running surfaces) formed from solid or sintered hydrophobic polymers to give low friction. To reduce friction yet further between the running surface and the glide surface it is known to coat the running surface with wax. A commonly used technique to apply wax involves hot ironing the wax into the base. Typically, this necessitates access to a workshop. Cold wax candles and preparations may be used between hot waxes but tend not to give such high performance because of inconsistencies in their application and because they quickly wear away through abrasion.

Wax coating of the running surface to reduce friction can increase speed, and hence raise performance and/or increase recreational enjoyment. It also helps to

protect the running surface from abrasive damage. A problem, however, is that the wax coating wears off, and re-application becomes necessary. When a wax coating has been workshop applied, wear is dependent on the distance travelled on the ski or board.

US Patent 5,169,169 discloses an attempted solution to this problem. This document describes a ski waxing system in which pumps (electrically or heel operated) are used to drive lubricant from a reservoir worn by the skier to the running surface of a ski. An alternative system is disclosed in which a chamber inside the ski body contains pressured gas, and this is used in a controlled fashion to drive lubricant from a further chamber inside the ski to the running surface. Although the described systems do enable wax to be applied to the ski during use, they have a number of problems associated with them. Firstly, wearing of a lubricant container (reservoir) by the skier (for example, on his or her back) represents a safety hazard, in addition to being a further encumbrance. Secondly, building compressed gas and lubricant chambers into the ski body can severely degrade its strength. Thirdly, the described systems employ discrete nozzles (outlet ports) in the running surface to dispense lubricant. These nozzles can be easily blocked, for example, by external fouling. Another disadvantage with the systems incorporating a single heel pump is that the pump puts an alpine skier into an unnatural and unsafe off-balance ski position. Also, the use of external connections (for example, piping to the reservoir and links to ski-pole mounted pump activation switches) causes safety risks through impact injuries or strangulation. Yet another problem with the systems disclosed in US 5,169,169 is that by utilising compressed gas, electrically activated switches and valves, and springs in heel pumps, they fall foul of ski competition equipment regulations, in particular, the Federation International de Ski (FIS) equipment regulation 1.2.6.1 2003/2004 which states "no additional equipment is permitted which: (a) makes use of foreign energy (e.g. heaters, chemical energy accumulators, electric batteries, mechanical aids, etc); b causes or intends to cause changes in the outer conditions of the competition to the disadvantage of fellow competitors (e.g. changes to piste or snow); (c) increase the risk for the users or other persons, when used for the purpose it was intended for.

Thus, the systems disclosed in US 5,169,169 contravene Part (a) when using compressed gases, electrically actuated switches and valves, pistons and springs, and

contravene Part (c) when using external compressed gas canisters and piping to the sticks and fluid reservoirs that can cause injury to the user and others. Thus the systems disclosed in US 5,169,169 would not be permitted in current ski competitions.

It is therefore an object of embodiments of the present invention to provide skis and/or snowboards with lubrication systems that overcome, at least partially, one or more of the above mentioned problems associated with the prior art. A particular aim is to provide skis and snowboards with lubrication systems that satisfy current specifications for competition equipment.

Summary of the Invention

According to a first aspect of the present invention, there is provided a ski or snowboard having a lower running surface and comprising: means for attaching a boot to the ski or snowboard; a deformable lubricant reservoir; and means for conveying lubricant from the reservoir to the running surface, the arrangement being such that, in use, an attached boot can exert pressure on the reservoir to deform the reservoir and drive lubricant from the reservoir, via the conveying means, to the running surface.

In other words, the reservoir and boot attachment means are arranged such that, in use, a wearer of the boot exerts a force on the reservoir to pressurise lubricant inside it, and so drive lubricant to the running surface. The reservoir is adapted to deform under pressure from an attached boot.

Thus, lubricant is forced from the lubricant reservoir to the lower running surface by action of pressure from a boot on the reservoir. This pressure may be applied directly or indirectly to the reservoir. It will be appreciated that, in use, the pressure applied by an attached boot to a ski or snowboard will vary with time and will also vary widely in magnitude. For example, the pressure may vary rapidly when the user is travelling over an undulating surface. Depending on the speed of travel and the contours of the slope surface, the instantaneous pressure on the ski may greatly exceed that which would be experienced by the ski when the user is stationary on flat ground. Thus, in use, the reservoir incorporated in the present invention will be subjected to time-varying pressure which can be thought of as a pseudo – random

series of pressure pulses. These pressure pulses are used to drive the lubricant from the reservoir to the running surface.

It will be appreciated that, because of the large fluctuation in pressure exerted by the attached boot in typical use, the reservoir may be semi-rigid or even substantially rigid, i.e. a significant force may have to be applied to achieve even a small deformation. The deformation need not be large. The rigidity of the reservoir may be tailored so that a suitable pumping action (that is driving of lubricant from the reservoir to the running surface) is achieved in the particular application. For example, for high speed, downhill racing applications, a stiffer reservoir may be used than for recreational use.

It will also be appreciated that in this first aspect of the present invention the "pumping" of the lubricant is achieved without using any actuators or switches. The activation is achieved solely by natural skier pressure. Displacement of the lubricant to the running surface is achieved using skier pressure alone.

Before use of the ski or snowboard, the reservoir is typically filled (or charged) with lubricant via a suitably arranged inlet, which may comprise a self-sealing (i.e. self-closing) valve for example. The refill supply is then disconnected, so that the reservoir is then a closed, self-contained local supply of lubricant, carried on the ski or snowboard itself. When the ski/board is in use, the reservoir is not connected to any lubricant supply; it has no open lubricant inlet, but just one or more lubricant outlets.

Preferably the reservoir is resilient, such that in use it is repeatedly deformed under pressure from the boot, and then returns to its original shape when pressure is reduced. This repeated deformation and recovery of the reservoir can drive the lubricant pumping action, and it will be appreciated that only small changes in reservoir dimensions may be required to achieve suitable lubricant flow.

Conveniently, the ski or snowboard may comprise a non-return valve through which lubricant flows from the reservoir to the running surface. A further non-return valve may be arranged to permit air to enter the reservoir (i.e. to enable air to be drawn into the reservoir, to take up a volume corresponding to the ejected lubricant).

Thus, pumping action may be achieved using no actuators or switches, but just with fluidic non-return valves with no user control or intervention.

The reservoir may comprise a single lubricant outlet through which lubricant is driven to the running surface, or a plurality of such outlets.

Preferably, the reservoir comprises an outlet arranged at or near a forward end of the reservoir such that it continues to be covered by lubricant even when the reservoir is nearly empty when the ski or snowboard is travelling down a slope.

Preferably, the means for conveying lubricant is arranged to convey lubricant to a plurality of positions on the running surface. It may have a branching structure, such that a plurality of positions may be supplied from a single outlet of the reservoir.

The means for conveying lubricant may take a variety of forms. It may comprise a conduit, which may, for example, comprise one or more tubes and/or channels. In certain preferred embodiments it may comprise a plurality of micro channels, that is channels having dimensions in the region of 1 to 2000 μm.

The means for conveying may be arranged to convey lubricant through the ski or snowboard to the lower running surface (i.e. it may be arranged to convey lubricant down through a body of the ski/board).

Preferably, the means for conveying comprises at least one plate attached to an upper surface of the ski or snowboard, the plate having an inlet arranged to receive lubricant from the reservoir and defining a plate conduit arranged to convey lubricant from the plate inlet over the upper surface (i.e. along a length and/or across a width of the ski or board). This plate may be described as a distribution plate or distributing plate, as it distributes lubricant from the reservoir to desired lubrication points/regions on the running surface.

In certain preferred embodiments, the means for conveying comprises a plurality of conduits each extending from different respective positions on the upper surface, through the ski or snowboard towards the running surface, and the plate conduit is arranged to convey lubricant to this plurality of conduits. The plurality of

positions may comprise positions spaced apart along a length and/or across a width of the ski or snowboard.

The plate conduit may comprise at least one channel in a lower surface of the plate, the plate lower surface being attached to an upper surface of the ski or snowboard. Thus, the plate conduit which conveys lubricant may conveniently be defined between the distribution plate and the upper surface of the body of the ski or snowboard.

In preferred embodiments, the reservoir may be attached to an upper surface of the plate, providing the advantage that the reservoir and plate together form a race-plate structure, elevating the boot attachment position. Thus, the distributing plate may also function as a race/riser plate.

Alternatively, the reservoir may be attached to an upper surface of the body of the ski or snowboard. Preferably, the ski or snowboard may further comprise at least one porous member having a lower surface and an upper surface, the porous member being arranged such that its lower surface forms part of the running surface of the ski or snowboard, and the means for conveying delivers lubricant from the reservoir to the upper surface such that lubricant can pass through the porous member to the running surface. The upper surface may be a surface parallel to the lower surface, or may have an alternative profile.

Delivery of the lubricant to the running surface through a porous member provides the advantage that, unlike use of discrete nozzles or apertures, the pores are less prone to blocking, and also this permits lubricant to be delivered over a greater surface area. In particular, it will be appreciated that relatively large particles or pieces of debris which could block a nozzle or delivery tube will simply be swept over the surface of the porous member, leaving its lubricant delivery capability undiminished.

Preferably, the ski or snowboard comprises a plurality of such porous members, distributed over the lower running surface.

Preferably, each porous member comprises a porous membrane. Advantageously, each porous member is mesoporous (i.e. it comprises pores having

diameters in the range 100 to 1000 nanometres, although larger pores will also prove effective).

Preferably, the reservoir is arranged above a body of the ski or snowboard, and the means for conveying lubricant is arranged to convey the lubricant down through the ski or snowboard body to the running surface.

The reservoir may be attached to an upper surface of the ski or snowboard, or may be attached to a race plate (also known as a rise plate or booster) which is itself attached to a ski or snowboard upper surface. The race plate may have dual function, in that it is also a distribution plate. Boosters are used between the ski upper surface and the ski boot bindings to elevate the position of the skier to enable tight cornering at high angles of angulation.

Alternatively, the ski or snowboard may comprise a race plate, and the reservoir may be housed inside the race plate itself.

Preferably, the means for attaching comprises a toe-binding and the reservoir is arranged beneath the toe-binding. Thus, the reservoir may function as a toe pump. The location of the reservoir at the toe enables the skier position to be optimised. A secondary heel pump may be used as well, offering combined performance which is slightly better than when using a toe pump alone.

The toe-binding may be attached directly to an upper surface of the reservoir. Alternatively, pressure may be applied to the reservoir from the toe-binding by means of some intermediate member or structure.

Preferably, the means for attaching a boot comprises a heel binding, which may be rigidly attached to the ski or snowboard body (directly, or indirectly by means of a suitable spacer member or plate), with no deformable reservoir beneath the heel binding. In such examples, the driving of lubricant to the running surface (i.e. the pumping) is achieved solely by means of pressure applied via the toe binding. Alternatively, the ski or snowboard may comprise a second deformable lubricant reservoir, which may additionally be arranged beneath the heel binding. In such examples, the means for conveying lubricant is adapted to convey lubricant from each reservoir to the running surface.

In certain preferred embodiments the deformable lubricant reservoir comprises a substantially rigid reservoir body and a flexible reservoir lid. A gasket may be arranged to form a seal between the reservoir body and lid. Advantageously, the gasket may comprise self-sealing elastomeric material and may be further arranged to seal a lubricant refill inlet to the reservoir.

Also, in certain preferred embodiments the means for conveying lubricant comprises a lubricant distribution system arranged inside a body of the ski or snowboard. In other words, the distribution system (which may be a system or pipes, tubes, channels or other conduits) may be an integral part of the ski body, embedded or otherwise incorporated in it. The distribution system is preferably arranged to distribute lubricant along a length of the ski or board, to a plurality of positions on the running surface. The distribution system may be connected via suitable connection means to a single outlet from the reservoir, or to a plurality of outlets. The connection means may, for example, include a short length of tube, pipe, or other conduit that is internal or external to the ski body.

According to a second aspect of the present invention, there is provided a ski or snowboard having a lower running surface and comprising at least one porous member, the porous member having a lower outer surface, which forms part of the running surface, and an upper surface, the ski or snowboard further comprising means for conveying lubricant to the upper surface such that lubricant may pass through the porous member to the running surface.

Thus, rather than supplying lubricant to the running surface through nozzles or other such orifices, this aspect of the invention provides the lubricant via a porous member. This provides numerous advantages. The porous outer surface of the porous member is less prone to blockage, enables lubricant to be delivered over a wide area, does not interrupt the otherwise smooth running surface of the ski or snowboard and, by avoiding the requirement for holes in the running surface, can offer a ski or snowboard with improved strength and structural integrity.

The porous member may be embedded in a body of the ski or snowboard such that its upper surface is a surface located inside the body.

The means for conveying lubricant may comprise at least one tube, channel or conduit extending down through the body to the upper surface of the porous member. Preferably the ski or snowboard further comprises a lubricant reservoir adapted to feed lubricant to the means for conveying lubricant. The ski or snowboard may further comprise pumping means to deliver lubricant to the porous member, although in certain embodiments gravity feed alone may be used.

In embodiments adapted to be worn by a person, the ski or snowboard may further comprise means for attaching a boot, wherein the reservoir is arranged to be deformed, in use, under pressure from an attached boot to force lubricant to the porous member. In such embodiments, the pumping means preferably comprises non-return valves arranged to allow lubricant to be pumped from the reservoir, and to allow air to be drawn into the reservoir as the reservoir is repeatedly flexed under pressure from the attached boot.

Preferably, the porous member is in the form of a porous membrane. Preferably the porous member or membrane comprises mesoporous material.

The ski or snowboard may comprise a lower polymer layer which forms the running surface and the porous membrane may be located in a window in the lower polymer layer, the surfaces of the lower polymer layer and porous membrane being co-planar.

Preferably, the ski or snowboard comprises a plurality of porous members, with their lower outer surfaces being distributed over the lower running surface.

A preferred embodiment of the invention provides a snowboard including a reservoir and a distribution plate, which together create a rise plate that allows riders with large boot sizes to additionally avoid catching their toes on the snow or artificial sliding surface when carving turns in the toe forward position, thereby increasing the carve efficiency and the comfort of the ride.

According to another aspect of the invention there is provided method of lubricating a running surface of a ski or snowboard, the method comprising the steps of: providing the ski or snowboard with a boot binding and a deformable lubricant reservoir beneath the boot binding; before using the ski or snowboard, filling the

reservoir with a quantity of lubricant; attaching a boot to the ski or snowboard using the binding; using the ski or snowboard and exerting a pressure on the reservoir whilst using the ski or snowboard to deform the reservoir and progressively drive said quantity of lubricant from the reservoir; whilst using the ski or snowboard, admitting air to the reservoir to replace expelled lubricant; and conveying expelled lubricant from the reservoir to the running surface of the ski or snowboard, whereby the quantity of lubricant is progressively delivered to the running surface during use.

Advantageously, the step of conveying may comprise conveying the lubricant down through a body of the ski or snowboard, for example using a distribution system incorporated in the body.

Brief description of the Drawings

Embodiments of the invention will now be described with reference to the accompanying drawings (not to scale) of which:

FIG 1 is a highly schematic representation of a ski embodying the invention;

FIG 2 is a schematic representation of a lubricant-conveying tube suitable for use in embodiments of the invention;

FIG 3 is a schematic representation of a micro engineered flexible plate (a distribution plate) carrying fluidic paths suitable for use in embodiments of the invention;

FIG 4 is a schematic cross section, along line A-A, of the plate from FIG 3;

FIG 5 is a schematic view of the underside of a ski embodying the invention showing porous members (shaded) incorporated into the running surface of the ski;

FIG 6 is a schematic view of the underside of another embodiment, showing open orifices of appropriate diameters incorporated into the running surface of the ski;

FIG 7 is a schematic plan view of a lubricant reservoir suitable for use in embodiments of the invention;

FIG 8 is a schematic cross-section of the fluid reservoir from FIG 7 ;

FIG 9 is a highly schematic view of part of another ski (including the toe binding) embodying the invention, showing part of the flexible fluidics plate;

FIG 10 is a highly schematic view of part of a vehicle comprising a ski embodying the invention;

FIG 11 is a high schematic view of a snowboard embodying the invention;

FIG 12 is a plan view of a base portion of a reservoir suitable for use in embodiments of the invention;

FIG 13 is a cross section of a reservoir suitable for use in embodiments of the invention, the reservoir incorporating a gasket, a top plate, and the base portion shown in FIG 12;

FIG 14 is a highly schematic cross section of a ski embodying the invention; and

FIG 15 is a highly schematic cross section of part of another ski embodying the invention.

Detailed description of preferred embodiments

Referring now to FIG 1, a first embodiment to the invention comprises a ski having a body 4 with a lower running surface 2 and an upper surface 3. Attached to the upper surface 3 is a hollow shell 5, having an upper surface 51, that acts as the lubricant reservoir. A forward reservoir 5 is located beneath a toe binding 6. The toe binding 6 includes a base plate 61 which is attached directly to the upper surface of the reservoir 5. In use, an attached boot 8 exerts a time-varying pressure on the reservoirs 5. A second reservoir 5 is located beneath a heel binding 7, having a heel binding plate 71 which again is attached to an upper surface of the rear reservoir. Before the ski is used, volumes V inside the reservoirs 5 (i.e. inside the shells or housings) are charged with suitable lubricant. The two reservoirs 5 are semi-rigid, in that they are deformed slightly under the time-varying pressure exerted via the boot 8. The reservoirs 5 are also resilient, so that when pressure is reduced they regain their original shapes. This repeated deformation of the reservoirs 5 causes a pumping action which is used to drive lubricant contained within the reservoirs 5 out of the reservoirs, via outlets 52, into conduits 10 provided inside distribution plates 9 which are attached to the upper

surface 3 of the ski. In certain embodiments, these conduits comprise an array of tubes, and in other embodiments they take alternative forms, such as channels. The reservoirs 5 are attached to upper surfaces 94 of the distribution plates. The distribution plates 9 in this example have inlets aligned with the outlets 52 of the reservoirs, and the plate conduits 10 distribute lubricant along lengths of the ski, to vertical conduits 11 which extend down from the upper surface 3 into the body of the ski. In this example the conduits 11 are bores which convey the lubricant through the body 4 towards the running surface 2, but do not emerge at the running surface. Instead, they terminate at the upper surfaces of porous members 42 which are set into the ski such that their lower surfaces 43 form parts (portions, areas or regions) of the running surface In normal use, a wearer of the ski exerts pressure on the reservoirs 5, deforming them and causing lubricant to be driven along the plate conduits 10, down through bores 11, and finally through pores in the members 43 to emerge on the running surface. In FIG 1, the connection between the reservoirs 5 and the distribution plates 9 are shown simply as apertures (of exaggerated size). In other embodiments, a valve may be arranged between the two components.

FIG 2 shows a delivery tube 100 which can be used in embodiments of the invention, as means for conveying lubricant from a reservoir to the running surface (or porous member). The delivery tube could, for example, be housed inside a distribution or race plate. It has a single inlet 101 to convey lubricant from a single outlet 52 of a respective reservoir, and branches to deliver that lubricant to two or more outlets 102. These can be arranged at delivery apertures 12 in the running surface 2 of the ski, or adjacent the upper surfaces of porous members set into the ski. One possible arrangement of the delivery apertures 12 is shown in FIG 6. FIG 5 shows porous membranes 42 incorporated into the running surface below apertures 12 that act to distribute the lubricant and protect against blocking. In other words, in the embodiment shown in FIG 5, the membranes cover delivery apertures, in the same way that the porous members 42 of the ski in FIG 1 cover the lower ends of the delivery bores 11. Outer surfaces 43 of the membranes 42 extend across the width of the ski and provide portions of the running surface 2.

It will be appreciated that the general lubricant delivery/dispensing system illustrated in FIGs 1, 2, 5 and 6 is applicable not just to skis, but to snow blades,

snowboards or any other devices which glide on snow or an artificial surface used for snow sport activities, such as ski-doos, sledges, ice skate blades, etc.

Figure 3 shows the underside of a distribution plate 9 suitable for use in embodiments of the invention. The plate has a lubricant inlet 91, for connection to the lubricant outlet 52. A lower surface of the flexible plate is substantially flat, for attachment to the flat upper surface of a ski or board body. This attachment may, for example, be by means of suitable adhesive. A plurality of channels or grooves 93 are provided in the lower surface 93, and these, in cooperation with the ski upper surface, define conduits 10 for conveying lubricant over the ski (i.e. distributing lubricant to delivery apertures or porous members). The plate is shown in cross section in FIG 4, and the position of one of the delivery bores 11 through the ski body is shown with respect to the channel.

Modern performance skis often have an integrated ski body, with a race/rise plate and binding device. The race plate is often a hollow plastic shell that provides for extra height of the ski boot above the ski surface thereby allowing a higher degree of ski edge angulation. This aids turn carving. In FIG 1, and in other embodiments, the reservoirs 5 may replace an otherwise unfilled race plate. In certain embodiments, the distribution plate and reservoir(s) may function as a race plate, elevating the attached boot above the ski upper surface.

In the embodiment showed in FIG 1, no user intervention is required other than to fill the lubricant reservoirs 5 (via refill ports, not shown). No outside control signal electrical or magnetic, is required to initiate the lubricant pumping action. The deformable reservoirs act as pumps which contain no actuators or switches. Activation is solely by natural skier pressure. The ski of FIG 1 uses a primary toe pump to provide optimum skier position, and a secondary heel pump was also used (but can be omitted in alternative embodiments). The lubricant supply system is a continuous flow system, with the release rate being determined by pressure exerted by the skier (and by non-return valves, in embodiments where they are used). It will also be appreciated that the system of FIG 1 comprises no moving parts.

Referring now to FIGs 7 and 8, these show a lubricant reservoir 5 suitable for use in the ski of FIG 1 and in other embodiments. This reservoir takes the form of a

semi-rigid, resilient container, which may be formed from aluminium, plastic, reinforced plastic, steel, or a combination of these materials. It will be appreciated that other metals and polymers, and indeed other materials, may be used in alternative embodiments. For example, the reservoirs may conveniently be formed from moulded and/or reinforced plastics. The reservoir 5 has an upper surface 51 including a connection 54 for a lubricant filler, a connection 53 for an air valve (i.e. a non-return air inlet valve) and four screw holes 55 for attaching the reservoir and the bindings to the other components of the ski. A vent with variable aperture size may replace the non-return air valve as a means of controlling the flow rate of the lubricant. Lubricant outlets 52 are provided in a lower plate 56 of the container. The container 5 thus takes the form of a generally rectangular or ergonomically and aerodynamically shaped box, having upper and lower surfaces connected by a sidewall 57. The small deformations of the upper surface 51 can be achieved by application of suitable skier pressures.

Referring now to FIG 9, in this embodiment the ski utilises a single deformable reservoir 5 acting as a toe pump. Again the reservoir 5 is attached to an upper surface 94 of a flexible fluidic distribution plate 9. A toe binding 6 is attached to an upper surface of the reservoir 51. A heel binding 7 may be attached directly to another shell 5 or to a hollow rise plate if fluidic distribution is not required at the heel of the ski. A non-return valve 53 is arranged to permit air to be drawn into the reservoir 5 when the reservoir 5 expands when applied pressure is reduced. When sufficient pressure is applied to the reservoir by means of the attached boot 8 and the toe binding 6, the reservoir deforms, acting in addition to gravity to force lubricant out through an outlets 52, via non-return valves 58 into fluid conveying networks 15. These networks include conduits 10 which branch into pairs of fluid channels 111 running down through the body 4 of the ski. In other embodiments, these channels 111 may emerge from the lower running surface of the ski through orifices or apertures 12. In the present example, these channels 111 deliver the lubricant to surfaces 44 of porous membranes 42. In this embodiment these surfaces 44 are upper surfaces, parallel to the lower, outer surfaces 43 of the membranes. However, it will be appreciated that the surfaces 44 may have other shapes in alternative embodiments. The channels 111 simply need to deliver lubricant to the porous members 42 such that it can emerge from the lower outer surface 43. The ski comprises a lower polymer

layer 21 which would normally provide all of the running surface 2. However, in this embodiment, windows have been cut in the polymer layer 21 and the porous membranes 42 are located in (i.e. they are set into) these windows such that the lower surface 2 of the polymer layer 21 and the outer surfaces 43 of the membranes 42 are co-planar. Thus, there are no large apertures in the running surface of the ski to become blocked, and the use of porous membranes covering the supply channels 111 enables an uninterrupted, smooth running surface to be provided, which can also deliver lubricant at a plurality of positions. In the embodiment of FIG 9 the non-return valve 58 in the lubricant supply path from the reservoir to the membranes 42 is housed at the fluid exit 52 of the reservoir 5. The channels 111 are provided inside the ski body itself. The londitudinal supply conduits 10, which also form part of the fluid conveying networks, are parts of a flexible fluidic distribution plate 9. Thus, this embodiment provides integral lubricant fluid storage, pumping and distribution with no external components. There are no components external to the main body of the ski and binding system so that the device works in inverted orientation (suitable for freestyle, and new school skiing) as well as with a normal stance as would be encountered in Alpine or Nordic skiing and boarding. The pumping of the lubricant is achieved by using a deformable reservoir and only fluidic non-return valves. No user control or intervention is required.

Referring again to FIG 9, it will be appreciated that each reservoir 5 has an outlet 52 located towards the front of the reservoir (and a second outlet further back as shown). From the forward outlet, lubricant can be supplied to a plurality of positions on the ski running surface. By locating an outlet at the front of the reservoir in this way, even when the lubricant level is low, lubrication of the running surface can still be achieved when travelling downhill. Only when the reservoir 5 is almost completely empty will supply to the running surface cease.

Referring now to FIG 10, this shows part of a vehicle incorporating a ski embodying the invention. The ski 1 is attached to the vehicle body 30 by means of a mounting leg 31 and mounting plate 32. Inside the vehicle is located a lubricant reservoir 20, supplying lubricant to a pump 21. The pump in turn supplies lubricant via a tube network 15 to inner surfaces 44 of an array of porous members 42. These porous members are arranged such that their lower outer surfaces 43 form parts of the

lower running surface 2 of the ski. When reduced friction is required, the pump 21 is operated to deliver lubricant to the porous members 42 and lubricant thus emerges from the lower surfaces 43. In certain circumstances, reduced friction may not be required, and then the pump 21 is simply left inactive.

Referring now to FIG 11, this shows another embodiment of the invention, in particular a snowboard. Here the snowboard 100 comprises a distribution plate 9 attached to an upper surface 3. A boot 8 is attached to the snowboard plate 9 by means of a binding 106. The raised reservoir 5 is hollow and flexible, and contains the lubricant L. A plurality of micro channels 15 convey lubricant from the reservoir 5 through a flexible fluidic distribution plate 9 to the upper surfaces of a plurality of mesoporous membranes 42, through which the lubricant emerges onto the lower running surface 2. In use, pressure exerted by the boot 8 on the reservoir 5 in turn causes repeated deformation of the reservoir 5 and drives lubricant through the micro channels 15 to the membranes 42. Thus, this embodiment employs a micro fluidic lubricant delivery and distribution system to improve glide of the board. The lubricant is distributed to the glide surface using mesoporous polymer membranes to increase surface area and avoiding fouling of fluidic channels. This embodiment requires no pre-pressurisation of a pumping device. The system can also be used with skis and snowblades and other gliding devices.. The pumping effect results only from the action of skier/boarder pressure in a natural skiing/boarding position. Positive displacement of lubricant is achieved using skier pressure only.

Referring now to FIG 12, this is a plan view of part of a lubricant reservoir suitable for use in embodiments of the invention. The depicted part 50 is the lower portion of the reservoir, which may also be referred to as the reservoir body. This body 50 defines a volume V for storing a quantity of liquid lubricant. In use, the reservoir body 50 is closed by a gasket 502 and lid 500 (or top plate). A cross section of the assembled reservoir 5 is shown in FIG 13, the cross section being taken along the line A-A in FIG 12. As will be appreciated from FIGS 12 and 13, the reservoir 5 is elongated, and in use is attached to a ski so as to extend longitudinally along a length of the ski. The reservoir body is generally symmetrical about a centre line, and will typically be attached to a ski so that this centre line is aligned with that of the ski. A front or leading portion 501 of the reservoir body is pointed so as to improve

aerodynamic performance, and although the rear portion is generally square in this example, in alternative embodiments both the front and rear portions may be suitably shaped to provide reduced drag. The storage volume V is defined by the combination of body base 507 and side walls 508 extending upwards from the base. It will be appreciated that the reservoir body may be manufactured using a variety of techniques. For example, it may be fabricated from separate components, or the volume V may be machined out of a single, initially solid component. However, in certain preferred embodiments the body 50 is a single moulded plastic component, providing strength, durability and light weight. For example, the body 50 may be injection moulded polypropylene. The side walls 508 include portions 580 of increased thickness. Extending vertically through these thickened portions 580 are a number of holes for receiving suitably sized fixing screws. These holes include pilot holes 550 for receiving screws to attach the reservoir to a ski upper surface (or to the surface of a rise or distribution plate mounted on the ski) and a plurality of smaller holes 551 for use in attaching a binding to the assembled reservoir. The side walls 508 provide a flat upper surface 509 on which the gasket 502 is located in the assembled reservoir.

Referring to the assembled reservoir of FIG 13, a neoprene or other elastomer gasket 502 is sandwiched between the upper surface 509 of the base side walls and the lower surface of a top plate 500. Although various materials may be used for the top plate, in certain preferred embodiments the top plate is formed from the same plastic material as the base. In use, when screws are used to attach the reservoir to a ski and binding, tightening of the screws clamps the gasket between the body 50 and top plate 500 to provide a seal. The only way out of the reservoir for the lubricant is then through the single outlet 52, located in the side wall, immediately adjacent the base 507 and at the front end of the reservoir. It will be appreciated that the thickness of the top plate determines its flexibility, and hence the deformation of the reservoir for a given applied force. In other words, the top plate thickness will determine the pumping action resulting from application of a given force. Thus, a plurality of top plates may be provided, having different thicknesses, and before commencing skiing the top plate thickness may be selected to suit requirements (e.g. depending on the skier's weight, surface conditions, and/or intended skiing style).

The top plate 500 is provided with a plurality of fixing holes at positions corresponding to those of the holes in the base 50, and although it cannot be seen in the figure, the perimeter of the top plate is typically arranged to correspond to that of the base (i.e. with a pointed front portion to match the base from FIG 12).

As mentioned above, in the present embodiment the gasket 502 is neoprene. Although not shown in FIGS 12 or 13, in addition to providing a seal between base and lid, this gasket may advantageously be utilised in a self-sealing reservoir fill system. For example, the gasket may be arranged beneath an aperture (e.g. window, nozzle, or some other conduit) in the lid such that a lubricant refill tube can be inserted into the aperture, through the gasket material, and into the enclosed volume inside the reservoir. After charging the reservoir via the tube, the tube can then be withdrawn, and the gasket material then reseals itself so that, again, the lubricant can only escape the reservoir via the outlet 52. Although neoprene may be used, it will be appreciated that other suitable self-sealing elastomeric materials may be used in alternative embodiments.

The reservoir of FIG 13 is intended for use as a toe reservoir, i.e. it is intended for attachment to a ski, either directly or via a rise/distribution plate, with a toe binding attached to the upper surface 51 of the reservoir top plate 500. In other words, it is adapted for location beneath a toe binding. It will be appreciated that suitable means are to be provided to connect the fluid outlet 52 to a distribution system able to convey expelled lubricant from the reservoir to the running surface of the ski.

Referring now to FIG 14, this is a highly schematic representation of a ski incorporating a single toe reservoir 5. The reservoir 5 may be of the type as described above with reference to FIGS 12 and 13. In use, application of force to the reservoir by means of the toe binding results in repeated deformation of the reservoir 5, which in turn results in lubricant being driven (pumped) out of the storage volume V through an outlet 52 located at the front of the reservoir. A short connection 151 connects the outlet to a lubricant distribution system 150 which conveys the expelled lubricant to a plurality of positions on the running surface 2 of the ski. In this example, the lubricant distribution system is incorporated entirely within the body 4 of the ski, and comprises a plurality of conduits. It will be appreciated that a ski incorporating a

suitable distribution system may be manufactured in a variety of ways. For example, tubes or pipes may be embedded in the ski structure, or channels may be provided in one or more of the laminate layers. To convey lubricant down to the running surface, tubes, pipes, or channels may be provided which extend through a number of the laminate layers. As with other embodiments, the distribution system may deliver lubricant to the running surface via discrete apertures in the running surface, or via one or more porous members. In this example, no heel pump is used. However, a spacer 70 is located between the heel binding 70 and the ski upper surface 3 so that the toe and heel bindings are at substantially the same height above the ski upper surface.

Referring now to FIG 15, in another ski embodying the invention a toe reservoir 5 is attached directly to the upper surface 3 of a ski, and a toe binding 6 is attached directly to an upper surface 51 of the reservoir 5. Pressure applied via the binding 6 causes flexing of the reservoir lid, and hence pressure pulses are applied to lubricant L inside the reservoir. An external conduit system 160 (i.e. it is external to the body 4 of the ski) conveys lubricant L from a reservoir outlet 52 to a plurality of positions on the ski upper surface 3. An internal conduit system (not shown), incorporated inside the ski body, then conveys the lubricant to a plurality of positions on the running surface 2 of the ski. The external conduit system may, for example, comprise a system of tubes or pipes attached to the ski upper surface 3. A one-way (non-return) valve 530 is attached to the reservoir and is arranged to allow air to enter the reservoir to replace expelled lubricant. The valve is adjustable to control the flow of air into the reservoir; it provides a variable resistance. By adjusting the valve, one is thus able to adjust the flow rate of lubricant out of the reservoir for given conditions. The reservoir is also provided with a plug 540 of self-sealing elastomeric material, the plug closing an aperture (e.g. window) in the reservoir top plate. A lubricant refill nozzle may be inserted into the reservoir through the plug (i.e. it can pierce the plug), the reservoir may then be charged with a quantity of lubricant, and the nozzle may then be withdrawn. The plug material then reseals, closing the reservoir to further liquid ingress.

It will be appreciated that embodiments of the present invention can provide integrated non-obtrusive ski and snowboard lubrication systems. Skis and

snowboards embodying the invention may adhere to FIS rules on equipment design, as the pumping systems use no external energy sources. They may replace currently used race/rise plates. Pumping occurs as a consequence of the skier's natural pressure with no external energy being supplied. Embodiments may employ distribution systems that are based on micro fluidic systems, thereby allowing precise spatial and temporal control of the lubricant delivery without user intervention. The means for conveying lubricant from the reservoir to the running surface may utilise a lubricant release system incorporating a mesoporous polymer membrane built into the gliding surface as an integral component. This reduces fouling that would be observed with direct holes in the glide surface. This enables the base of the ski or snowboard to remain flat with no added surface grooves or apertures. Embodiments of the invention may employ a microfluidic distributor formed from moulded plastic, or other convenient material to be integrated into the top surface of a ski or board.

Certain embodiments of the invention use micro channels to distribute lubricant (which would typically be an environmentally friendly formulation based on a number of organic, inorganic and aqueous components) from a reservoir contained in the ski body to the base (i.e. running surface) at well defined points of need. Pumping is achieved using the pressure of the skier on the boot foot plate of the binding.

Skis embodying the invention have been shown in controlled tests to have superior speed and hence race performance and a longer lifetime between relubrication in a recreational environment. Furthermore, because of the constant release system the lubricant does not wear off as a function of distance travelled, thereby giving superior constant glide.

In certain embodiments of the invention, micro channels in an extension to the race plate are used to convey lubricant from a reservoir to the glide surface, thereby preserving the structural integrity of the ski body. Use of a membrane distributor integrated into the glide surface avoids the problems associated with blocking of fluidic channels.

Certain embodiments use skier pressure alone to drive lubricant from the reservoir to the glide surface. Alternatively, gravity flow alone can be used, given the

correct choice of lubricant. In other embodiments, a combination of gravity and skier pressure assisted flow may be used. Changes in skier pressure can be used to re-enforce the effects of gravity, as can the steepness of the slope down which the device is travelling.